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The current work presents a modeling study of the thermal behavior during discharge of a hydride hydrogen tank. In a thermal coupling between a fuel cell and its associated hydride hydrogen tank, the hydrogen desorption kinetics depends on temperature, nature of the hydride, the tank design, but also on the hydrogen demand from the fuel cell in terms of mass flow and pressure. The objective of the study is to demonstrate the dynamic response of hydrogen discharge from a metal hydride tank by using the fluidic electrical analogy.

Model

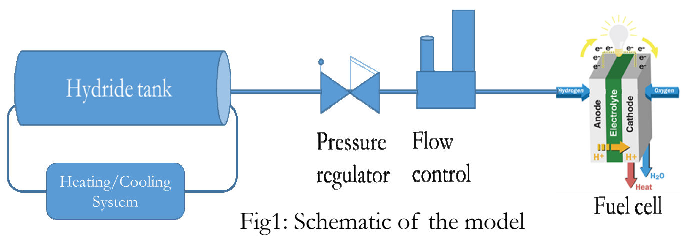


Fig1: Schematic of the model

Supply line

Control element

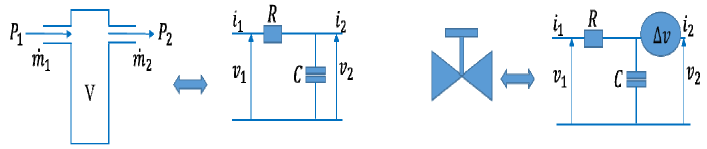
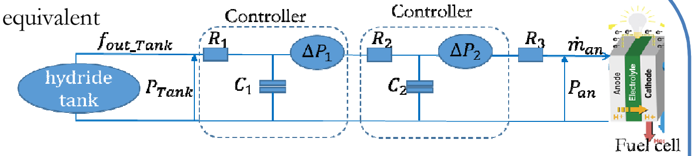


Fig2: Electrical fluidic analogy

Fig3: Electrical model equivalent



$$(\rho Cp)_e \frac{dT}{dt} = \dot{m}\Delta H + Q \qquad Q = \frac{\dot{m}_w c_{p,w}}{V_{MH}}(T_{w,in} - T_{MH})(1 - e^{-\alpha})$$

$$\varepsilon \frac{\partial \rho_g}{\partial t} = -\dot{m} \qquad \alpha = U\pi D\, L/\dot{m}_w\, c_{p,w}$$

$$(1-\varepsilon)\frac{\partial \rho_s}{\partial t} = \dot{m} \qquad T_{w,\mathrm{out}} = T_{MH} + (T_{w,\mathrm{in}} - T_{MH})e^{-\alpha}$$

$$\dot{m} = C_d \exp\left(-\frac{E_d}{RT}\right)\left(\frac{P_g - P_{eq}}{P_{eq}}\right)(\rho_s - \rho_0)$$

Results

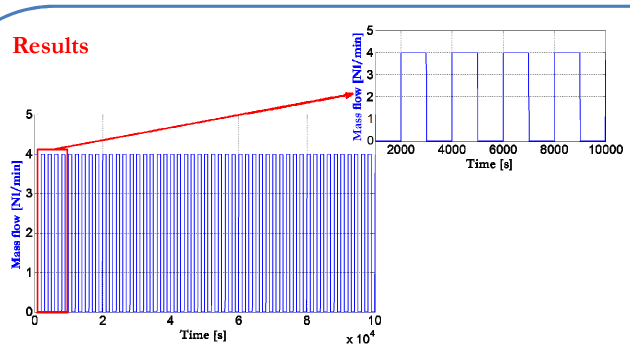


Fig4: Flow demanded by fuel cell

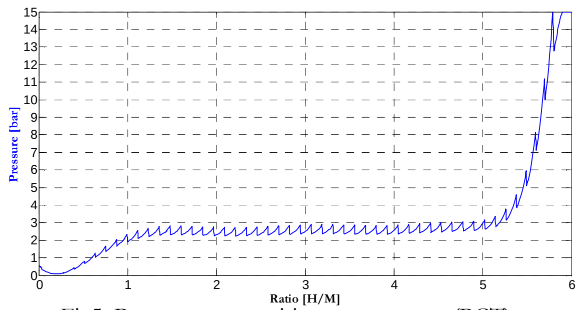


Fig5: Pressure composition temperature (PCT)

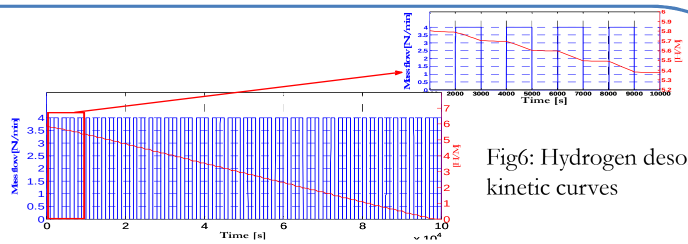
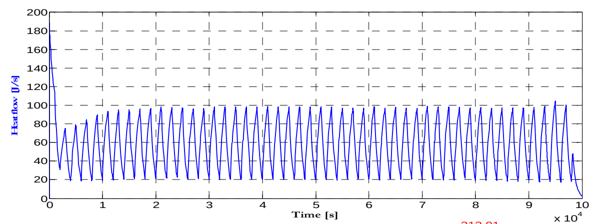


Fig6: Hydrogen desorption kinetic curves

Fig7: Heat transfer rate



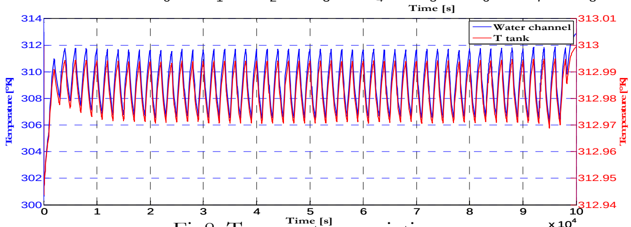


Fig8: Temperature variation

The future work will demonstrate more characteristics of hydrogen supply for various operational demands of a fuel cell system with an enhanced simulation accuracy using higher- dimensional models. Also, the dynamics of fuel cell system performances will be explored with the goal of enhancing the control strategies of hydrogen supply with optimizing control parameters

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